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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "One year of aerosol refractive index measurement from a coastal Antarctic site" *by* Z. Jurányi and R. Weller

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The authors would like to thank Anonymous Referee #2 for their helpful comments and suggestions.

reviewer comment: My main concern is that, in some parts more than in others, the language needs polishing, beyond what can be expected to be caught during the ACP-language editing at the end of the publication process. I will not list all these occurrences where the English has to be approved, but give at least an already longish list in this review at "Technical comments".

answer: A thorough language editing of the text was done.

reviewer comment: page 5, line 5: Information on where exactly particles entered the

tubing during these experiments would be good. Just underneath the roof, close to the inlet line?

answer: For these experiments the instrument was repositioned and the inlet line where the instrument was connected before was closed and the tubing was removed from the inlet. The particles entered the tubing from somewhere middle of the measurement container. The following sentence was added to the page 5, line 4: "The room air was measured by disconnecting the tubing from the inlet and sucking air from inside the measurement container."

reviewer comment: page 6, line 1-2: You show this polynomial only up to 400nm - although the data (blue dots) go up to 1000nm - does this mean you only used particles up to 400nm? Please add an explanation and/or prolong the line in Fig. 1.

answer: Yes, polynomial fit was done only in the size range of 120-340nm, as it is stated two lines before: "For the RI fit only this size range of the number size distribution was used." For clarification the text now reads: "In the diameter range of the RI determination of 120–340 nm, the efficiency is between 0.77 and 0.67. The losses are significant here as well, but we consider this still as correctable. To have a continuous correction factor, the transmission efficiency (Fig. 1, blue dots) was fit within the diameter range of interest a polynomial line."

reviewer comment: page 6, line 24 ff: I have an idea what you did, here, but I am not entirely sure – this could certainly be formulated much clearer. What I think you did is the following: (1) - calculate TIR for a fixed RI (2) - take the value from the TIR at the diameter of the PSL particles. I guess one confusion was due to your use of the word "bin boundary diameter". Maybe this could be defined once and then "LAS diameter" could be used instead, throughout the text, to make the text flow better? Also, this passage sounds as if there would basically only be a signal in one bin during a PSL calibration - this is most likely not the case. Describe this more clearly.

answer: The text now reads: "(TIR, the signal which the instrument measures) of the

LAS for both PSL particles (TIR_PSL) and for particles with the desired RI (TIR_RI) as function of the particle diameter" "The LAS delivers the number size distribution (n(D)) as the particle number concentration (N(D)) sorted into diameter bins: n(D_i)= dN(D_i)/dlog(D_i), where i denotes the ith diameter bin. These bins cover the whole measurement range of the instrument leaving no gaps. Each diameter bin has a lower and a higher boundary (D_i,lower, D_i,higher). These diameter bin boundaries correspond to the PSL calibration of the LAS. In order to recalculate the number size distribution to another RI, all bin boundary diameter has to be recalculated. This recalculation can be done by using the previously calculated TIR values: (1) For a single PSL calibration based bin diameter (D_i,PSL) the instrument response TIR_PSL(D_i,PSL) is looked up. (2) Now we look at the TIR values that are calculated for the desired RI. We search at which diameter (D_i,RI) we get the same instrument response as for PSL (TIR_RI(D_i,RI)=TIR_PSL(D_i,PSL)) and that diameter is the recalculated bin boundary diameter. We repeat this for every diameter bin. The diameter recalculation is not always straight-forward, because OPCs using a monochromatic laser often suffer from a non-monotonic instrument response at higher diameters (e.g., Hodkinson and Greenfield, 1965; Barnard and Harrison, 1988). This problem of non-monotonic instrument response was solved by smoothing the calculated instrumental response function by fitting a 5th grade polynomial to the logarithm of both TIR_PSL and TIR_RI functions. Figure 2 shows an example how a single bin boundary diameter (D30_PSL, the 30th diameter bin border) is recalculated using another (m=1.4+0i) RI. "

reviewer comment: page 8, line 15-16: Concerning possible changes in particle composition: The way you did your derivation of RI, however, was to assume that the particle chemistry was the same for all particles in one measured size distribution? Please explicitly say this here somehow, as I got confused by your remark here.

answer: No, it was not assumed, that the particle chemistry was the same for all particles in one measured size distribution for the RI derivation. But we derive an RI which matches only the real aerosol RI if all the particles have the same chemical composi-

tion (actually only the same RI, particles with different chemical composition still might have the same RI) in the measured size distribution. Otherwise if the aerosol population is described with a single RI value, it is some kind of average value. Since we derived the RI using only the number size distribution in the 120-340nm particle size range, the derived RI corresponds to this size range as well, and has no information on the particles with diameters outside of this size range. If the RI changes significantly with the size, our derived RI might not be equal to the average RI considering the whole aerosol population. To make this clearer the text now reads: "The RI derived with our method is representative for the size range of 120–340 nm, which was used for the RI calculation. If we can assume that all particles in the number size distribution have the same RI, our calculated RI is the true RI. If the chemical composition of the aerosol is changing with the particle size, it is possible that the RI is also size dependent. Hence our derived RI might differ from the average RI which corresponds for the complete aerosol population. In addition, we we assumed a spherical shape of the particles and a negligible imaginary part of the RI. Therefore we term our derived RI the effective refractive index (RI_eff) from now on, and for later conclusions we have to keep in mind that the RI_eff might not be the true RI of an individual particle."

reviewer comment: page 8, line 29-30: "We used the method introduced in the sections 2.5 and 2.6 to determine the RI of this e-cigarette smoke." But in the paragraph above you said that the RI of the cigarette smoke was 1.43, based on literature (and if you would have had to determine it first you would run into issues with circular reasoning if you then would use this measurement to calibrate the LAS TIR). I assume this again is an issue with formulating the text. Please review.

answer: In this section (as its title says as well) we wanted to verify our RI calculation method and especially the particle loss correction. This is the reason why we wanted to have an aerosol source which has a known refractive index. If we make a measurement and calculate the RI with our method and it agrees well with the literature value of the test aerosol (e-cigarette smoke in our case), then we know that our method (calculation and loss correction) works well. This is what we did here. We modified the text for clarification: "We used the method introduced in the sections 2.5 and 2.6 to calculate the RI of this e-cigarette smoke, first with the uncorrected LAS data then with applying the above introduced (Section 2.3) LAS correction. These values can be compared to the e-cigarette smoke's literature RI value of 1.43 to check whether the LAS correction works well or not."

reviewer comment: page 9, line 4-6: Again confusing, so let me ask you again if this is what you did: When retrieving the RI for the uncorrected LAS data, you obtained an RI of 1.35, but when you corrected the measured LAS size distribution as described above and then retrieved the RI again, you got a value of 1.43, in agreement with literature. - If this is what you did, feel free to use my sentence here in the review instead of what you wrote. Your text here was hard to follow and it took me a while until I understood what you (likely) meant.

answer: Yes, this is exactly what we did. This should be now clear after the changes in the text stated after the previous comment, and here: "Without using the LAS correction on the LAS data (green lines) we get an RI of 1.35 from the best fit. This value is significantly lower than the literature RI value of 1.43 suggesting that the LAS losses had a high influence on the retrieved RI and that a correction is necessary. When we corrected the measured LAS size distribution as described above (Section 2.3), the best fit between the SMPS and the LAS data (blue lines) resulted in the RI of 1.43 which is in agreement with the literature value. This verifies our LAS correction, and we applied it on all LAS data before November 2017."

reviewer comment: page 12, first paragraph of 3.5: I would recommend to start this paragraph differently – the first sentence states something that seems not to hold once one read the list of RIs: when looking at this list and the most abundant components of the aerosol, one wonders if this really can be in good agreement, since particularly sea salt and ammonium sulphate are clearly above the value you retrieved. This all becomes much clearer further down, but I recommend to avoid confusion and to remove

this first sentence or replace it with a sentence that says what you are aiming at in 3.5.

answer: The first sentence was replaced with this: "The aerosol chemical composition shows a strong seasonal variation at our measurement site. The dominant aerosol component is sea-salt with around 50 % of the total mass in summer..."

reviewer comment: page 17, line 2: Maybe add that you expect this because scattering scales with the diameter squared

answer: Added: "... as expected, because scattering increases faster than linearly as function of the particle diameter. "

reviewer comment: page 18, first paragraph: You spend most of the space in this paragraph on discussing why this one value does not make sense, and the reason basically is that the underlying data is corrupted. Maybe just do not present the blue line in the figure and say up front that due to a) the strange kink in the LAS distribution and b) due to the low particle number concentration at the larger particle diameters no useful value resulted. (I'd be afraid that otherwise in the future someone might just grab that value from your figure without reading the text and use it.) Also, this lowering for particles $>\sim$350 nm, together with the bimodality you showed in Fig. 9 - could this point towards two different sources for particles? This is something you could discuss here, instead.

answer: The blue line was removed. The paragraph was modified: "The conspicuously lower RIeff in the highest investigated size range may originate from a significantly changing chemical composition. Interestingly, sea-salt particles should dominate this higher size range, but this would result in a higher RIeff. Hence one may speculate about a coating of sea-salt particles in this special case (probably organic material with typically lower RI). The presence of a coating or a different aerosol source might also explain the bimodality of the scattering coefficient size distribution (Section 3.8)."

reviewer comment: page 6, line 26: Do you really mean an OPC (i.e., a counter) or rather an OPS (optical particle sizer)? (Check this also in the introduction, line 19 on page 2).

answer: Optical particle counters (OPCs) are not only counting but also sizing the particles, they are just for some historical reason called counters. Optical particle sizer is just a newer name for the same instrument. The older name, in our opinion, is better known and therefore we would like to leave it as it is.

reviewer comment: page 8, line 9-10: This again is a strangely formulated sentence.

answer: The sentence was changed to: "The Chi function was determined for every single m value, and the minimum of this function was searched. The m value, where Chi reaches its minimum is the m we look for and we interpret as the RI of the measured aerosol."

All other technical comments were accepted and all suggested corrections were done. âĂČ

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